K2 Photometry of Qatar-2b: A Hot Jupiter Orbiting a K Dwarf Amenable to Characterization

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Qatar 2 (GSC 04974-00112, Kp = 13.02) is a 0.743 solar mass K dwarf star that hosts a 2.494 Jupiter Mass Hot Jupiter planet (Bryan et al. 2012, ApJ, 750, 84) that falls on the active silicon for campaign 6 of the K2 mission. The Hot Jupiter planet, Qatar 2b, has an orbital period of 1.3371182 days and a corresponding semi major axis to stellar radius ratio of 6.489. With such a short period and at a semi major axis at less than 3 times the fluid Roche limit of it's host star, Qatar-2 is an excellent candidate for short cadence photometry using K2 in order to probe the previously observed stellar activity of the host star (Mancini et al. 2014, MNRAS, 443, 3) and in order to search for transit timing variations and photometric variation in ellipsoidal variations. As a result we request short cadence observations of Qatar 2 during Campaign 6 of the K2 mission.

Each of the three goals listed for this proposal would benefit from the high precision photometry K2 will provide. Similarly bright K0 targets (Kp 13-13.1) have produced 6 hr precision levels of ~60-65 ppm using techniques which account for the nonuniform pixel response function of the Kepler detectors by correlating flux measurements with the spacecraft's pointing and removing the dependence (Vanderburg and Johnson 2014, PASP, 126, 944). Stellar spot variations have been several factors larger than these values and have been indicative of high stellar activity beneath the planet's transit chord. Greater stellar activity and magnetic activity of the host star in tandem with Qatar 2b's relatively high density and cooler expected planetary equilibrium temperatures as compared to inflated Hot Jupiters may help bound conditions for inflation of close in gas giants. Observations using K2 would help explore this stellar activity and its influence on system and bulk parameters.

Estimates for combined ellipsoidal variations in both the star and planet are calculated to be at least 40 ppm using the lowest values for albedo (~0.1) to over 200 ppm for larger values (~0.5) also predicted in literature. This range of values is below the limit of ground based observations but should exceed the precision levels expected from K2 – this additional signal to noise constitutes the significant added value that K2 observations would provide over ground based data. The high precision photometry of K2 would enable characterization of the photosphere of Qatar 2b in addition to the stellar photosphere and could enable analysis of potential asphericity driven signatures (Saxena et al. 2015, MNRAS, 446, 4) that may lurk within the lightcurve of Qatar 2. Such variations would help supplement previous characterization of the atmosphere and bulk properties of Qatar 2b. The high cadence observations of this short period planet will provide very precise measurement of transit mid-times and subsequently would allow for high quality TTV analysis. While increased stellar activity can often confound TTV study, the higher photometric precision of K2 versus ground based observations would compensate for the lower 30-minute cadence and allow stronger TTV constraints – again demonstrating the additional value such a proposal would have over ground based studies.

The team that would work on the data analysis proposed for Qatar 2b is highly qualified to work on this project. Joshua Pepper (Pepper et al. 2013, ApJ, 773, 1), Carolina von Essen (von Essen et al. 2014, A&A, 561, 48) and Joseph E. Rodriguez have substantial expertise in extracting system and bulk parameters from data analysis of transiting exoplanets. Michael Summers and Prabal Saxena have shown the capability of extracting asphericity signals and derived bulk parameters from interpretation of transit light curves. Finally, Dr. von Essen and other members of the team have access to meter class telescopes that may be able to provide corroborating follow up observations of Qatar 2b.